

Fraunhofer, at the beginning of this century, pointed out the coincidence of place in the spectrum between certain dark lines which he saw in the spectrum of the sun and the bright lines in the spectrum of the flame of a lamp. In Dr. Brewster's note-book, dated St. Andrews, Oct. 28, 1841, this passage occurs:—"I have this evening discovered the remarkable fact that, in the combustion of nitre upon charcoal, there are definite bright rays corresponding to the double lines of A and B, and the group of lines *a* in the space A B. *The coincidence of two yellow rays with the two deficient ones at D, with the existence of definite bright rays in the nitre flame, not only at D but at A, a and B, is so extraordinary that it indicates some regular connection between the two classes of phenomena.*"

We next have an important experiment made by Foucault in 1849, who pointed out that the electric arc presented us with a medium which emits the rays D on its own account, and which at the same time absorbs them when they come from another quarter.

The received explanation of this coincidence between the two bright lines of burning sodium vapour, and the two dark lines D in the solar spectrum, which extended the grasp of spectrum analysis from terrestrial substances to the skies, was taught by Prof. Stokes in his lectures about 1852, but was not published.

In 1853 the idea was first published by Angström.*

In his memoir, for the purpose of illustrating the absorption of light, he made use of a principle already propounded by Euler, in his *Theoria lucis et caloris*, that the particles of a body, in consequence of resonance, absorb principally those ethereal undulatory motions which have previously been impressed upon them. He also endeavoured to show that *a body in a state of glowing heat emits just the same kinds of light and heat which it absorbs under the same circumstances.* He further undertook researches on the electric light, and stated that in many cases the Fraunhofer lines were an inversion of the bright lines, which he observed in the spectrum of various metals.

Early in 1859, Mr. Balfour Stewart independently discovered the law which binds together radiation and absorption, establishing it experimentally as an extension of Prévost's law of exchanges in the case of the heat rays, and generalising his conclusion for all rays.

In October of the same year, 1859, Kirchhoff established experimentally the same law for the light rays.

On the occasion of Angström's admission to the membership of the Royal Society, General Sabine in his introductory address mentioned that the obstacles opposed by the language in which Angström's treatise had been written, and by distance from the scene of his investigations, had for three years prevented its very existence from being known to the scientific world at large; but when once the nature of that treatise became known, the fact was immediately acknowledged, that in Professors Stokes and Angström we are bound to recognise the fathers of spectral analysis. Indeed, in the "*Optiska Undersökningar*" of the latter are to be found many of the fundamental principles of much that has since been accomplished in that department of scientific inquiry. In his work entitled "*Recherches sur le spectre solaire*," with its atlas of the normal spectrum of the sun, Angström has given us an

* "*Optiska Undersökningar*:" Trans. Royal Academy of Stockholm, 1853. Translated in Phil. Mag. 4th series, vol. ix. p. 237.

indispensable adjunct for all future students of spectrum analytical investigations.

We have already stated that Angström published memoirs on subjects connected with nearly every department of physical inquiry. Thus we have papers:—(1) "*Sur la polarisation rectiligne et la double réfraction des cristaux à trois axes obliques*" (Upsala Vetenskaps-Societets Acta), in which he gives the solution of the problem involved in the optical phenomena presented by such crystals which had been sought, but without success, by Neumann and MacCulloch. (2) On the "*Monoklinoedrisk kristallernas molekylära Constanter*" (Vet. Akad.'s Handlingar, 1859). (3) "*Ny metod at bestämma kroppars ledningsförmåga för Värme*"—New method of determining the capacity for conducting heat in the human body—(Vet. Akad. Förh. 1861); which contains the first determinations ever given of the absolute values of the capacity for conducting heat. (4) "*Sur deux inégalités d'une grandeur remarquable dans les apparitions de la Comète de Halley*" (Upsala Vet. Soc. Acta.). This treatise first excited the expectation amongst astronomers of obtaining certain results by means of a single method. (5) "*Sur les Spectres des gas simples*" (*Comptes Rendus*, 1871).

These are among the most important of Angström's numerous treatises, and in addition we may instance his celebrated monograph, "*Mémoire sur la température de la terre*" (Upsala Vet. Soc.'s Acta.), as well as a paper belonging to an earlier period, which appeared in the "*Denkschriften der Münchener Academie*," 1844, under the title of "*Magnetische Beobachtungen bei Gelegenheit einer Reise nach Deutschland und Frankreich*."

As might naturally be expected, numerous scientific Societies sought the honour of numbering Angström amongst their members, as for instance:—Kungl. Vet. Akad. i. Stockholm; Kungl. Vet. Akad. i. Upsala; the Royal Societies of Berlin, Copenhagen, London, &c. He was, moreover, appointed Corresponding Member of the French Institute; he twice obtained the Wallmarksk prize of the Vet. Akad. of Stockholm in 1865, in conjunction with Professors Thalén and H. Holmgren, and in 1869 with the former alone. He carried off two other prizes given by the same Society, and once he obtained a grant of money for his observations from the University of Upsala, before he had become a member of the Upsala Vet. Soc., which was the more acceptable to him, since for a long period he reaped a very inadequate pecuniary return for his scientific labours. Partly by the aid of the State, but mostly at his own personal expense, Angström several times visited the Continent, especially France and Germany. He was absent from Sweden in the years 1843, 1844, 1859, and during the summers of 1866 and 1867; but with one exception he attended all the meetings of the Scandinavian Association for Natural and Physical History. In recognition of his great merits, Angström was made Knight of the "Order of the North," and Commander of the Vasa Order 1st Class, and of the "Crown of Italy."

THE IRON AND STEEL INSTITUTE

THIS prosperous and useful association held its sixth summer meeting last week, from the 1st to the 4th instant, at Barrow-in-Furness, a town whose rapidity of growth is unparalleled out of America. Twenty-five years

ago the village of Barrow, near the southern extremity of the peninsula of Furness, in Lancashire, had a population of barely 200; now the municipal borough extends over an area of about 15,000 acres, with a population of about 35,000. Even fourteen years ago, when the first volume of *Chambers' Encyclopædia* was published, it seems to have been so little known, or of so little importance, as not to find a place in that useful work. It is now a well-laid-out town, with fine docks, and some of the most important iron and engineering works in the kingdom; while one of the steel works are considered to occupy a leading position in connection with the manufacture of Bessemer steel. This unequalled growth of the town of Barrow is entirely owing to the rapid development of the various industries connected with iron, the mineral deposits of the district being unusually rich.

Such a town forms an appropriate meeting-place for an Institute which has done so much to develop the manufacture of iron and steel, by affording a medium for the interchange of ideas between those who are engaged in the practical work of these industries or in the investigation of the scientific principles on which they must be founded if they are to be successful. The Institute is to be congratulated on the scientific tone which has all along pervaded its proceedings and its publications since it was founded in 1869. Though it has had such a comparatively short existence, it seems to have been in all respects prosperous (it now numbers close on 600 members), and to have most satisfactorily fulfilled the purpose for which it was instituted, the improvement of the all-important manufacture of iron and steel by the free interchange of ideas generated by experience or scientific study. To quote the words of our contemporary *Iron*: "Anterior to the establishment of this important society, the manufacturers of iron in its various forms had scant opportunity of communicating in public the results of their own experience, and of comparing those results with the observations of other persons equally interested in their development. Various methods of working prevailed in different parts of the country, and not long ago many processes connected with iron and steel manufacture were regarded as trade secrets to be carefully treasured up and jealously guarded. To the abolition of these narrow and antiquated notions the Iron and Steel Institute addressed itself vigorously from its very inception. It soon became apparent that among the first promoters of the society there prevailed an earnest desire to cast aside all petty jealousy, and to add unreservedly their individual knowledge to the general stock of information. Adherence to this excellent principle produced a prompt effect on the minds of iron and steel makers in all parts of the British Empire, and secured the sympathy of continental and American manufacturers." This is a very valuable result to have been accomplished in so short a time, and may perhaps partly be accounted for by the high scientific character of those who have from the first been elected to hold office in the society. With such names on its list of office-bearers as his Grace the Duke of Devonshire, Mr. Isaac Lowthian Bell, F.R.S., Mr. Bessemer, Mr. John Jones, F.G.S. (general secretary), Mr. David Forbes, F.R.S. (foreign secretary), Dr. C. W. Siemens, F.R.S.,

and others, the Institute has every chance of doing good work and of imbuing its members with a feeling of the necessity, in order to secure the highest success in their important industry, of importing into it continually the results of the latest and highest scientific research. There is little fear of the practical side of the iron and steel manufacture being neglected; and if this as well as other similar Institutes, do their work faithfully, and if the members enter upon their work equipped with a thorough scientific as well as professional training, there will be little fear of other nations outstripping us in this, as they threaten to do in other industries. To keep up the tone of the Institute, the importance of electing right men to hold office in it cannot be too much insisted on, and we hope that in this respect it will go on as it has begun.

The Barrow meeting seems to have been a real success; the only complaint being, as is almost always the case at such meetings, the difficulty of getting sleeping accommodation for the members; in Barrow this is not to be wondered at, as the people have scarcely had time yet to think about building hotels. The Duke of Devonshire, who is intimately connected with Barrow, the Earl of Lonsdale, the Mayor, and other dignitaries, as well as the railway companies and proprietors of the numerous works in and around Barrow, entertained the members most hospitably, and gave them every opportunity of inspecting the working of the numerous vast establishments connected with the industries with which the Institute is concerned. Indeed, the greater part of the four days seems to have been spent in visits and excursions; and considering the nature and aims of the Institute, its time could not, perhaps, have been more profitably spent. A good many papers were also [read, all of them of considerable practical value, but of too purely technical a nature for these columns. Among the more generally scientific we may mention Mr. Wurzburger's very interesting and well-informed paper on the Geology of the West Coast Iron Ore Districts, and Mr. Charles Smith's paper on the Iron Ores of Sweden. The last day, September 4, was entirely devoted to an inspection of various mining works in the West Cumberland district.

Altogether we have no doubt that the members of the Institute will look back upon the Barrow meeting as one of the pleasantest and most instructive they have had. The Right Hon. Earl Granville has been elected president for the years 1874-6.

SHARPE'S "BIRDS IN THE BRITISH MUSEUM"

Catalogue of the Birds in the British Museum. Vol. I.—Accipitres. By R. Bowdler Sharpe. (Printed by order of the Trustees.)

THE great value of Dr. Günther's "Catalogue of Fishes" in the British Museum is appreciated by all working zoologists; and when Mr. Sharpe was appointed one of the Senior Assistants in the Natural History Department of that noble institution, ornithologists had every reason to hope for an equally important work on the birds in the same collection, all fully realising Mr. Sharpe's perfect competency for the execution of so